being in the deep soundings between the islands of St. Thomas and Ste. Croix.

During the same day two other slight shocks, one at about 10 A.M. the other at noon, were felt at St. Thomas; they were unaccompanied by noise. W. G. PALGRAVE

St. Thomas, W.I., March 21

Physical Axioms

CONVINCED that the fulfilment of astronomic predictions can never *demonstrate* the laws of motion, and yet feeling myself quite destitute of intuitive belief in those laws, I have been led to think that in the present controversy truth may lie somewhere between the positions respectively enunciated by Mr. Spencer and his critic.

By reasoning which seems to me equally lucid, ingenious, and unanswerable, Mr. Spencer has shown that certain ultimate mechanical laws are tacitly assumed in every process of experimental verification. But I do not see that this vitiates *completely* the inference drawn from such verifications. The pure empiricists argue that because certain observed results coincide with the results of calculation, therefore the assumptions on which the calculation was based must be true. Now without doubt the *demonstrative* character of this inference vanishes entirely under Mr. Spencer's searching criticism. But it seems to me that a *high probability* remains behind. For were there any but an excessively minute error in the laws of motion, our astronomical observations could agree with the results of calculation only by a conflict of errors—a conflict which Mr. Spencer himself hints at. But there are overwhelming chances that these errors would not be so accurately adjusted throughout an immense variety of cases as exactly to compensate one another in every single instance. Hence I cannot but regard the laws of motion as hypotheses, the truth of which is shown by experiment to be overwhelmingly probable. The doctrine here assumed may be illustrated by an appeal to those old friends of probability students—the dice. If I throw double sixes ten times running I naturally conclude that the dice are loaded. This supposition almost necessarily involves the sameness of the ten throws, whereas the supposition that they were not loaded is consistent with an immense number of other results. Our minds choose the former alternative in obedience to an instinct which might with much show of propriety be formulated into an axiom. We may, however, deduce a justification for it from two ultimate intuitions of our nature—belief in uniformity of sequence and the general doctrine of chances—intuitions by which the mind apprehends respectively the ultimate law of knowledge and the ultimate law of ignorance. Belief in any special fact beyond individual experience can be rationally arrived at only by applying the former law to that knowledge which our individual experience furnishes, and the latter law to that ignorance which our individual experience has failed to enlighten.

It is the *approximate* truth of the laws of motion to which I have throughout referred. That there may be an *excessively minute* error in all physical and even all geometrical principles, Prof. Clifford has long ago shown how unphilosophical it is to deny.

F. W. FRANKLAND

Royal College of Chemistry, April 18

The Fertilisation of Fumariaceæ

Apropos of the interesting discussion on this subject which has appeared in your columns, I should much like to know whether any of your readers have observed the mode of fertilisation in *Corydalis claviculata*. Last summer I spent a considerable time in attempting to find this out, but without success. In every flower which I gathered in the mature state, I found the style broken off at the articulation immediately above the ovary, as if to prevent the possibility of fertilisation after a certain period. As the interior parts are completely concealed by the corolla, it was difficult to determine whether the separation had actually taken place on the flower, or was the result of the dissection, but I believe the former to be the case. In a large number of observations, extending over a considerable time, I never saw an insect visit the plant (this was in Westmoreland), though seeds were freely produced. Müller does not mention this species in his classical work on the subject, "Die Befruchtung der Blumen durch Insekten." ALFRED W. BENNETT

ALLOW me to bring before the notice of readers of NATURE a small point bearing on the fact of the bright hue presented, after fertilisation, by the flowers of *Fumaria capreolata*.

Is it not possible that the pale colour may be more attractive to the fertilising insects than a brighter one would be? May not the drawing-principle be the result of correlation between the art-manifestations of the attracting and the æsthetic susceptibilities of the attracted organism, and not depend solely on gaudiness of the flower? If this be so, we know that these susceptibilities have, at any rate sometimes, a very limited range, as is seen in the bee-orchis, where the similarity of the labellum to the body of a bee is very close, both in colour and in form, and cannot be useless, seeing that a great amount of developmental force is expended in its production. On this view also the rejection of highly-coloured poisonous caterpillars may in part be referred to the non-agreement of their hues with the orthodox colour-notions of birds. On the other hand, if mere gaudiness is aimed at, why should there be such diversity exhibited? why would not one colour answer the purpose in every instance?

The present case is capable of ready explanation on the supposition that it comes under the influence of natural selection; for, as Mr. Spencer has shown, the hue of the flower results from a diminished amount of nutritive material supplied to the coloured parts, so that the least vigorous individuals would have these most highly coloured at the time of fertilisation. But since the pale flowers are preferred by the insects, they would stand a better chance of being fertilised than would the bright ones, so that a process of selection would be set up resulting ultimately in the disappearance of the latter.

If it be established that cross-fertilisation is not the rule with the flowers of this fumitory, of course it is a fact which has nothing whatever to do with the present argument, and the explanation given by Messrs. Darwin and Müller is entirely satisfactory. I cannot but think, however, that special attention will bring to light many cases of cross-fertilised flowers becoming more highly coloured after fertilisation, the phenomenon being explained simply as a decomposition-phase in the life-history of the contents of the cells composing the coloured organs.

S. MOORE

I VENTURE to suggest the following as possibly an explanation of the fact observed by Mr. Traherne Moggridge, that the flowers of *Fumaria pallidiflora* attain their brightest colouring when the time for their fertilisation has past.

In plants with a racemose inflorescence the individual flowers do not open simultaneously, but more or less in succession. The flowers lowest in the raceme open first: by the time they have in *Fumaria pallidiflora* attained their brighter colour, those a little higher up on the rachis are just at the stage for fertilisation, and the former may serve to attract insects to the latter, just as in some plants (*e.g.* Poinsettia) we may presume that the highly-coloured bracts attract insects to the comparatively inconspicuous flowers which they surround. The flowers a little way up the raceme would serve in their turn to attract insects to those above them; and these again to those still higher; the process going on for a considerable time in Fumaria, as it is quite common for the pedicels in the lower part of a raceme to be bearing fruit that has attained its full size, while at the top there are flower-buds still unopen.

Quisqualis indica affords another instance of flowers assuming a more intense colour after fertilisation. Its flowers grow in short spikes; on first opening and during fertilisation, are white, very faintly tinged with pink; but subsequently turn a light reddish-orange, and finally a purplish-red. T. COMBER

Newton-le-Willows, April 7

Power of Memory in Bees

ILLUSTRATIONS drawn from experiments or observations made upon animals lower than ourselves in the scale of life must always possess great interest. That impressions received by us in early life are more permanent than those made in after years, and that the memory of the old is less retentive in the reception of new impressions than is that of children, are circumstances universally acknowledged. On October 29, 1873, I removed a hive of bees in my garden, after it was quite dark, for a distance of 12 yards from the place in which it had stood for several months; and between its original situation and the new one there was a bushy evergreen tree, so that all sight of its former place was obstructed to a person looking from the new situation of the hive.

Notwithstanding this change, the bees, every day, flew to the locality where they formerly lived, and continued flying around the site of what had been their home, until, as night came on, they many of them sank upon the grass exhausted and chilled by the cold. Numbers, however, returned alive to their new position,

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after having looked in vain for their hive in its old place. At night I picked the exhausted bees up, and, having restored warmth to them (by leaving them for a time upon my coat-sleeve), I returned them to their companions.

Here was an illustration that the faculty of *memory* was superior to that of *observation*; but that was not all. Nearly every bee which I picked up during the twenty-three days through which this effort of memory lasted was an *old one;* as was easily deduced from observing the worn edges of the wings: showing that, whilst the young insects were quick in receiving new impressions, and in correcting errors, the nervous system of the old bees continued *acting in the direction which early habit had affected.* So true is it that "One touch of *Nature* makes the whole world kin."

Marlborough House, Torquay JOHN TOPHAM

Pollen-grains in the Air

WILL you allow me to ask Mr. Hubert Airy, in reference to his interesting paper on the "Microscopic Examination of Air," in NATURE, vol. ix. p. 439, on what ground he refers the "triangular pollen" captured on his slide to the birch and hazel? Observations of my own have led me to the conclusion that the pollen of plants which depend exclusively on the wind for their fertilisation is perfectly spherical, at all events before the form of the grain is disturbed by the emission of the pollen-tubes, and this indeed one might expect from *à priori* considerations. Among the pollen-grains I have especially observed, are those of *Corylus avellana*, *Betula alba*, and *Populus balsamifera.* I shall be much obliged if any of your readers could refer me to any accurate published description of the form of pollen-grains beyond those contained in Fritzsche's "Beiträge zur Kenntniss des Pollen." ALFRED W. BENNETT

6, Park Village East, N.W.

Lakes with two Outfalls

I AM a little surprised to find, by the recent letters in your paper, that Science makes so wide a mouth over this phenomenon, though its exceptional character, and the general correctness of Colonel Greenwood's theory, must readily be recognised. My surprise is occasioned by the fact that Norway, which is now visited by thousands of educated English tourists every year, can supply, not one, but several, I had almost written many, apparent examples of this double outflow. I have not myself passed the watershed at the Lesjeskaagen Lake, though I was close to it in August last, and would have examined it if I had known its importance; but I know enough of the locality to think that Colonel Greenwood is probably right in his explanation of it. But there is another, which I have passed, and which is situated on perhaps the most frequented route in Norway, viz. that from Lærdalsören over the Fille Fjeld, to which I hardly think the same explanation would apply. Between Nystuen and Skogstad is a chain of lakes crossing the watershed, the highest of which (not the one marked on the Vei-cart over Norge, I think) sends its waters to the west, past Nystuen to the Sogne Fjord, at Lærdalsören, and on the east by the Lille Mjösen, and Aadalen to the Tyrifjord, and so past Drammen to the Christiania Fjord. This lake is a small one, and the double outflow is close to the high road. I cannot imagine any commercial object for an artificial cut, and it must be well known to hundreds who annually pass it. The Vei-cart shows several other instances, I know not how authentic, though I have always found it fairly accurate, erring rather by omission than commission. But in lat. 62° N., long. 24° 40′ E. or thereabouts, is a very remarkable watershed, having a complication of outfalls; the Bredals-Vand sending one to the N.W. to the Geiranger Fjord, and a second to the Vaage-Vand and Gudbrandsdalen; which is also joined by a draft from a lake to the S.W., which likewise sends a feeder to the Opstryen Vand, and so W.S.W. to the Nord Fjord. This I have not myself seen, but I was at Merok on the Geiranger for some days last August, and was assured by my landlord that the map was correct in this particular. As the Norwegian peasantry are well-educated, intelligent, and truthful, and this route forms their regular short cut to Christiania, I cannot doubt but that it is the fact. However, I have engaged to go over the track this summer with Captain Dahl, the well-known jolly commander of the *Erknö*, and I will take care to ascertain the truth and report the result. If, moreover, there are any geological or geographical points to be attended to, and Colonel Greenwood will kindly furnish me with instructions, I shall be happy to attend to them.

I have a strong recollection of having passed two or three cases of double outfall on a small scale in my wanderings; but not having been aware of the importance of the point, I did not take notice sufficiently precise to enable me now to put my finger on them with certainty, but my general conviction is strong, that Norway can furnish several, if not many examples, which are the more significant from the fact that it is one of the oldest countries in the world. W. B. THELWALL

Burghley Road

WILL you permit me to correct a mistake as to a matter of fact in NATURE, vol. ix. p. 441. Loch-na-Davie, Arran, has two outlets, as is correctly represented in the Ordnance Map, and also in that in Bryce's "Geology of Arran." In August 1872 I walked up the north stream from Loch Ranza to its outfall from Loch-na-Davie. I think Colonel Greenwood ought at least to have made himself acquainted with the Ordnance Map.

Edinburgh A. CRAIG CHRISTIE

THE "CHALLENGER" EXPEDITION *

IV.

TRISTAN D'ACUNHA

AMONGST the places in the Atlantic marked out by the Circumnavigation Committee as being of especial interest, the small island of Trinidad is noted with those whose vegetation is absolutely unknown, or all but so. From this fact Trinidad became a point of attraction which Mr. Moseley was most anxious to reach. Owing, however, to unfavourable winds and other causes, as well as to a desire of those in command of the ship to proceed south, the visit to this little island was abandoned, with the hope of calling there on the return voyage. After a narrow escape, also, of missing Tristan d'Acunha, the vessel anchored on the north side of the island, and the morning was spent in searching the low lands under the cliffs, 500 feet being the greatest height that was attained during the stay. On this side the island rises in a range of perpendicular cliffs of black volcanic rock, in appearance somewhat similar in structure to that exposed in section in the Grande Cural in Madeira. At the base of the cliffs here are *débris* slopes, and a narrow strip of low shore land of an irregular rocky and sandy nature. The settlement lies on a stretch of low land, broader and more even, and extends westward. The ascent to the plateau above the cliffs is comparatively easy, owing to the deep gullies by which the cliffs are broken.

Though the extent of the island is small, its actual area being not more than 16 square miles, the botanising was confined to the irregular strip of shore land just alluded to, and to the gully immediately above the settlement. Further exploration would have been made, but a sudden squall coming on, the recall was hoisted from the ship, and the party had to leave the island, after a visit of only six hours. Grasses, sedges, mosses, and ferns grow on the cliffs, and occasional patches of *Phylica arborea* Th., a rhamnaceous tree peculiar to the islands, as well as a species of *Empetrum*; these plants, however, are more prominent towards the summit. At the foot of the watercourses under the cliffs are bright green patches of *Rumex frutescens* Th. Mosses and liverworts cover the lower part of the cliffs, and the latter also abound beneath the grass in some situations to such an extent, indeed, as to cover the earth as with a green sheet. *Spartina arundinacea* Carm., grows in rounded tufts amongst the other herbage, and in the clefts of the rocks was seen in abundance *Asplenium obtusatum* Forst., and *Lomaria alpina* Spreng. It is remarkable that the plants of *Lomaria* when found in stony places, and in a comparatively starved condition, were mostly furnished with fertile fronds, whilst those growing in rich vegetable mould were barren. Amongst flowering plants the most common were *Apium australe* Th., *Pelargonium australe* Jacq., *Sonchus oleraceus* L. our common annual sow-thistle, *Hypochæris glabra* L. a closely allied plant to the sow-thistle, and also found in many parts of England. A cinchonaceous plant, *Nertera depressa* Banks, was very abundant, and

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* These Notes are founded on letters sent home by Mr. H. N. Mosely. Continued from p. 451.

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